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APPROVAL SIGNATURES		DATE
Bill Jackson (original signature on file)	Deputy Director	4/13/01

REVISION HISTORY			
Rev No.	Description of Change	Author	Effective Date
Basic	Initial Release	Bill Jackson IT/215	8/15/97
A	Pages 4 through 9 changed to reflect IV&V purchased, DCR-9A review comments incorporated	Bill Jackson IT/215	3/6/98
B	Ames SLP format	Bill Jackson IT/215	4/29/98
C	Quality Record - format changes	Bill Jackson IT/215	8/26/98
D	Section 6.3 is modified to include the technical report for design and verification reviews. Section 8.0 is modified to add technical report to quality records	Bill/Jackson IT/215	10/8/98
E	References to Ames Quality Manual replaced with references to IV&V Facility Quality Manual	Bill Jackson IT/215	09/10/99
F	Format and Number changes; Delete Reference to Ames Research Center	Griggs	12/01/00
G	Modified to correct Quality Record identification	Costello	4/16/01

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REFERENCE DOCUMENTS	
Document Number	Document Title
NPG 1441.1	NASA Records Retention Schedule
IVV 05	Document and Data Control
IVV 09-4	Project Management
IVV 16	Control of Quality Records

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1.0 Purpose

The purpose of this system level procedure (SLP) is to establish a consistent method for providing IV&V technical services to customers, sufficient to ensure safety and risk mitigation for the successful deployment of software-intensive systems.

2.0 Scope

This procedure is applicable to IV&V technical activities provided by the NASA IV&V Facility which includes design control of ISO standard in participation of customer design review and verification review which affect quality throughout the customer's software lifecycle.

3.0 Definitions

3.1 Verification: The process of determining whether or not the products of a given phase of the software development cycle fulfill the requirements established during the previous phase.

3.2 Validation: The process of evaluating software at the end of its software development process to ensure compliance with software requirements. This process ensures that the software system performs to the customer's expectations under operational conditions.

3.3 NASA Project Manager: The Civil Service person designated by the Deputy Director(s) as responsible for the performance of the IV&V activities for a particular project.

3.4 Analyst: The Civil Service or subcontractor person assigned to perform a specific IV&V task.

3.5 Program: The technical, financial, and management elements of the IV&V customer.

3.6 Complete: All attributes fully defined to ensure full implementation. A specification is complete to the extent that all of its parts are present and each part is fully developed. Completeness is the measure of the degree of

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thoroughness of the translation and hence the measure of the adequacy of the level of detail to initiate the next phase in the development cycle.

3.7 Consistent: Uniform and not in conflict with other requirements. A specification is consistent to the extent that its provisions do not conflict with each other or with governing specifications and objectives. Consistency is concerned with measuring the degree to which the specification of a given development phase is in agreement with the previous development phase.

3.8 Correctness: Determines that the data entered, processed, and output by the application system is accurate and complete. Accuracy and completeness are achieved through controls over transactions and data elements. The control should commence when a transaction is originated and conclude when the transaction data has been used for its intended purpose.

3.9 Feasible: A specification is feasible to the extent that the life cycle benefits of the system specified exceed its life cycle costs. Feasibility also includes verifying that a system can be developed that satisfies the specified requirement with respect to resource engineering.

3.10 Maintainable: The software is maintainable to the extent that it can be modified as necessary to correct problems or to respond to changing requirements. Attributes that may affect the maintainability include complete, concise, and readable documentation of design, operations, and support as well as modular software implementation.

3.11 Acronyms:

COTR	Contracting Officer's Technical Representative
IV&V	Independent Verification and Validation
CCHR	Catastrophic/Critical/High-risk

4.0 Flowchart

This section is not applicable to this process.

5.0 Responsibilities

The responsibilities are defined in Section 6, Procedure.

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6.0 Procedure

The Project Manager responsibilities are as defined in IVV 09-4, Project Management.

The IV&V analysis tasks for an individual project shall be defined in the associated project plan (ref: IVV 09-4, Project Management). The following IV&V analysis tasks are typically performed.

6.1 Phase Independent Analyses

These tasks may be performed by analysts throughout the software life-cycle.

6.1.1 Criticality Analysis/Risk Assessment

The analyst shall assess the software functions for criticality and risk. Criticality analysis will be based on the potential consequences associated with an error in or failure of the function. Risk assessment will be based on the likelihood of an error in or failure of the function. The analyst will document the assessment rationale and quantify both criticality and risk. The results of this analysis will be used to identify catastrophic, critical, high-risk (CCHR) functions.

This analysis will be performed on a frequency as specified in the project plan. The Project Manager will use this information for the further definition of tasks and for the allocation of available resources.

6.1.2 Traceability Analysis

The analyst shall analyze the successive stages in the development or progress of a requirement for correctness, consistency, completeness (sufficient detail to show compliance) and accuracy. This analysis is performed to ensure that system requirements are properly allocated to hardware and software requirements and that the allocated requirements are carried through to design, implementation and test.

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6.1.3 Issues Tracking

The analyst shall document all problems identified as a result of an analysis. The analyst shall attempt to communicate and resolve problems with the development community informally. Informal resolution of problems shall be documented. Problems which cannot be resolved with the developer at the informal, working level are candidates for elevation to an issue. If the problem is approved as an issue by the Project Manager, it shall be documented as an issue and its status towards resolution updated and reviewed monthly.

6.1.4 Metrics Assessment

The analyst shall utilize the program's software metrics and analyses results to identify deficiencies in the program's ability to comply with program requirements and schedules. The metrics may include processor sizing, processor timing, mass memory sizing, software development and test schedule, and software errors.

6.1.5 Loading Analysis

The analyst shall perform a loading analysis on the associated computer system design. The analysis shall examine processor and input/output loading during high-loading operations.

6.1.6 Change Impact Analysis

The analyst shall assess that a proposed change is complete, meets the intent of the change, is necessary, and that all performance and operational usage impacts are identified. These assessments may pertain to flight rules, crew procedures, hardware, software and system requirements

6.1.7 Special Studies

When tasked by the Project Manager, the analyst shall develop a plan for performing a special study. This plan shall address description, approach, reporting, schedule, impact to ongoing efforts, and steps to mitigate impacts to ongoing efforts. For subcontracted efforts, COTR approval is required prior to initiation of performance. The results of the special study shall be documented in a final report.

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6.2 Phase Dependent Analyses

These analyses are performed during a given software life-cycle phase (requirements, design, implementation, test).

6.2.1 Documentation Reviews

The analyst shall review phase-dependent documentation for internal consistency, technical adequacy (e.g., requirements are unambiguous and testable), completeness, traceability to and consistency with higher level documentation, feasibility, and appropriate level of detail.

6.2.2 Process Analysis


The analyst shall review process documentation to address the degree to which the documents meet the goals of the Data Item Description documents to which they were produced. The analyst may perform analyses in the following process areas: Software Interface Control, Software Configuration Management, Software Development, Software Test, and Software Integration. The analyst may assess the processes for implementation according to the associated plans and for appropriateness for the program environment at the time of the analysis.

6.2.3 Software Requirements Analysis

The analyst shall perform analyses to ensure that the requirements form a solid basis for design and that the requirements are appropriate for the expected operational usage of the software. Documentation to be analyzed may include: System Segment Specifications, Software Requirements Specifications, Interface Requirements Documents, and System Segment Design Documents.

6.2.4 Interface Requirements Analysis

The analyst shall analyze the Interface Control Documents (ICDs) to verify that the software requirements are correctly reflected in ICDs and to ensure that data and command initiation and response assumptions that are implied/specified within the ICDs are consistent with the specified requirements in the associated requirements documents.

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6.2.5 Software Design Analysis

The analyst shall perform analyses to assess the technical features and accuracy of the design, to analyze critical algorithms and control logic design (eg, determine performance, constraints, input/output discontinuities, feasibility), to evaluate modular interfaces and database design, to validate the testability of the design, and to review timing and sizing. Design phase documentation may include: Software Design Documents, Interface Design Documents, Software Product Specifications, and Database Design Documents.


6.2.6 Code Analysis

The analyst shall perform analysis of the source code to verify correct, complete and accurate implementation of the software requirements and design specifications. The analyst shall assess the maintainability and ability of the code to be properly and accurately reconfigured.

6.2.7 Analysis of Program's Verification and Validation Test Program

The analyst shall analyze the development contractor's verification and validation testing program to ensure: complete and adequate test coverage; validity of the test definition; proper acceptance criteria; sufficient planning of tools, facilities, procedures, methods and resources; adequate planning for regression testing; and correct and complete traceability with test documents. The analyst shall recommend specific changes to the developer's test plans and procedures whenever inadequacies are identified. Test documents to be analyzed may include: software test plans, software test descriptions, software test reports, design verification objectives, and design verification requirements.

The analyst shall recommend selected tests to be monitored and specific test results to be independently analyzed (COTR approval required for subcontracted effort). The analyst shall document the results of program's formal test of requirements and the results of analysts verification of the requirement implementation.

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6.2.8 Supportability Analysis

The analyst shall perform analyses to verify that the software being developed is maintainable. The analyst may assess the Software User's Manuals, Computer System Operator Manuals, Firmware Support Manuals, and the Software Product Specifications. The analyst may assess the maintainability of the software and its ability to be properly and accurately reconfigured.

6.2.9 Technical Reviews

The analyst shall develop a Software IV&V Report to be presented at each program major milestone review. Attendance, participation and reporting may be required for the following reviews: Integrated Design Review, System Requirements Review, System Design Review, Software Specification Review, Preliminary Design Review, Critical Design Review, Test Readiness Review, Functional Configuration Audit, Physical Configuration Audit, and Formal Qualification Review.

6.2.10 IV&V Testing

The analyst shall recommend independent testing with the objective of verifying agreement between software and software specifications and demonstrating the software's adequacy to perform the mission. The proposed testing should complement rather than duplicate the developer's testing. The COTR shall approve the recommended test plan if developed by subcontractor efforts. The scope of the independent testing shall be based on objectives, mission criticality, issues raised with the developer's test plans and procedures and available resources.

6.2.11 Certification of Readiness

The analyst shall assess the readiness of the software to support each mission and submit an input to the program's Certification of Readiness process. The input shall be based on the appropriateness of the software configuration, adequacy of the certification activities, and the adherence to program processes. The Certificate of Readiness shall be reviewed and signed by the Project Manager.

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6.3 Technical Report

At the conclusion of an analysis activity, the analyst will prepare a technical report. The report will include (1) statement of the issues addressed or events reported during the analysis of design review and verification review; (2) summary of principle conclusions and/or major issues; (3) supporting technical detail or other information; and (4) recommendations for further action.

7.0 Metrics

This section is not applicable to this process.

8.0 Records

All forms, reports, and documents generated as a result of this procedure may be distributed either electronically or by hard copy to fulfill the requirements of this procedure. They shall be controlled as defined by System Level Procedure 4.16 and retained as defined in the chart below.

Note: for records retention refer to new NASA Directives System as a NASA Procedures and Guidelines (NPG) for NASA Records Retention Schedules (NRRS), NPG 1441.1. This is a new NASA policy for ISO 9000 records.

Document Name and Identification Number	User Responsible for Record Retention	Retention Requirement	Location
Certification of Readiness Statement	Project Manager	Permanent - Retire to FRC when file is closed	Project File Electronic File